



ENERGY REPORT

ENERGY ENGINEERING ANALYSIS PROGRAM

ENERGY SAVINGS OPPORTUNITY SURVEY

**FORT HUACHUCA, ARIZONA
1994**

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Marie Wakefield,
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**EEAP Energy Savings Opportunity Survey
Fort Huachuca, Arizona**

1.0 Executive Summary

1.1 Introduction

This report summarizes all work performed for the Energy Engineering Analysis Program (EEAP) Energy Savings Opportunity Survey (ESOS) at Fort Huachuca, Arizona, authorized under Contract DACA05-92-C-0155 with the U.S. Army Corps of Engineers, Sacramento District, Sacramento, California.

The purpose of this study is to develop projects and actions that will reduce facilities energy consumption and operating costs at Fort Huachuca. Implementation of these projects will contribute to achieving the goal of the Army Facilities Energy Plan of a reduction in energy consumption per square foot of building floor area of 20 percent by FY2000 from FY1985 baseline levels.

The facility survey and evaluation effort was limited to 21 buildings and a specific set of energy conservation opportunities (ECOs) having a high likelihood of proving to be economically feasible. Also included were feasibility evaluations of cogeneration alternatives including (a) cogenerating alternatives serving the existing central heating/cooling plants, (b) a generating facility sized to serve the total electric power requirements of Fort Huachuca and (c) a generating facility sized to serve the total power requirements of both Fort Huachuca and the adjacent city of Sierra Vista. Both turbine generators and reciprocating-engine generators were evaluated for a cogeneration facility serving the two central heating/cooling plants.

Harmonic distortion sampling at four buildings containing significant computer loads or electronic fluorescent ballasts was also included in the study scope.

1.2 Energy Conservation Projects

Successful ECOs were packaged into project groups containing similar trades in order to eliminate the extra charges associated with subcontractor services. A Work Request (EHSC Form 4283-1) was prepared for each project group. Each programming document included complete supporting data: retrofit descriptions, energy and cost savings calculations, construction cost estimates and life cycle cost analysis summaries. Data summaries for each of the project groups appear in Table 1-1.

Each of the following ECOs was found to be cost-effective in at least one of the buildings studied:

- Roof and wall insulation
- Low emissivity roof coating
- Replacing electric motor-driven chiller with gas engine-driven chiller
- Economizer and supply air temperature reset controls
- High-efficiency motor retrofits
- Lighting fixture and control retrofits

EEAP Energy Savings Opportunity Survey Fort Huachuca, Arizona

1.3 Cogeneration Feasibility

A number of cogeneration alternatives serving either one or both of the central heating/cooling plants and containing either gas turbine or gas-fired reciprocating engine prime movers were evaluated. A summary of life cycle cost analyses for these central heating/cooling plant cogeneration alternatives appears in Table 1-2. The recommended alternative, based on highest savings-to-investment ratio (SIR), is a cogeneration facility serving both central heating/cooling plants and containing ebullient-cooled gas-engine generators with single-stage absorption chilling and steam heat exchangers to provide chilled and hot water for building HVAC use.

A summary of life cycle cost analyses for power generation facilities sized to serve Fort Huachuca and the City of Sierra Vista appears in Table 1-3. Generation facilities of the sizes required to serve Fort Huachuca and Sierra Vista cannot be served from existing gas distribution on post or upstream from Southwest Gas Corporation's Fort Huachuca regulating station. Budget costs for installing gas supply piping from a point 4.5 miles from the potential generating facility site were included in the investment amount. However, an in-depth engineering analysis to determine the need for additional facilities must first be performed by Southwest Gas Corporation before the overall economic feasibility of a power generating plant serving Fort Huachuca and the City of Sierra Vista can be determined.

1.4 Harmonic Distortion Survey

Harmonic distortion monitoring conducted at a representative sample of four buildings revealed that all measured voltage distortion levels were within the 5 percent recommended by ANSI/IEEE Standard 519. Current distortion percentages measured during early May were generally higher than those recommended by Standard 519, but are expected to fall within the guidelines during peak summer electrical demand periods when linear motor loads increase dramatically.

**EEAP Energy Savings Opportunity Survey
Fort Huachuca, Arizona**

Table 1-1. Project Group Summaries for Recommended ECOs

Building or ECO Number	Retrofit Description	Energy Savings Electric (kW)	Gas (Million BTU/Yr)	Energy Cost Savings			O&M Savings (\$/Year)	Utility Rebate (\$)	Investment (\$)	Payback (Years)	SIR
				(\$/Year)	Electric Gas (\$/Year)	LCC (\$/Year)					
Building Envelope Modifications											
15544	Wall & Roof Insul + Low E Roof Coat	0.0	27,827	442	\$1,750	\$1,556	\$43,080	\$0	\$0	\$24,210	7.32
20200	Retrofit Roof Insulation	0.0	4,029	64	\$253	\$226	\$6,245	\$0	\$0	\$4,147	8.65
43083	Roof: Insulation & Low E	0.0	124,909	1,228	\$7,857	\$4,318	\$155,623	\$0	\$0	\$58,567	4.81
51005	Apply Low E Roof Coating	0.0	(14,401)	928	(\$906)	\$3,264	\$35,364	\$0	\$0	\$16,822	7.13
56301	Apply Low E Roof Coating	0.0	149,852	567	\$9,426	\$1,994	\$141,556	\$0	\$0	\$6,437	0.56
91114	Apply Low E Roof Coating	0.0	5,460	(16)	\$343	(\$57)	\$3,321	\$0	\$0	\$1,498	5.23
Subtotal, Building Envelope Modifications		0.0	297,676	3,214	\$18,724	\$11,301	\$385,191	\$0	\$0	\$111,681	3.72
Gas Engine-Driven Chiller Retrofit											
56301	Gas Engine-Driven Chiller - 72 Tons	67.0	267,690	(1,823)	\$21,508	(\$8,218)	\$142,078	(\$1,032)	\$0	\$122,512	9.99
Building HVAC Control Modifications and High Efficiency Motor Retrofits											
56301	Economizer Control & SA Reset @ OA Temp	0.0	382,501	28,726	\$1,577	\$1,443	\$39,403	\$0	\$0	\$16,548	5.48
15544	SA Fan HVAC Unit	1.2	10,783	0	\$679	\$0	\$10,235	\$0	\$80	\$1,356	2.00
43083	SA Fan AHU No. 1	0.2	2,068	0	\$130	\$0	\$1,963	\$0	\$46	\$476	3.66
43083	SA Fan AHU No. 2	0.2	2,068	0	\$130	\$0	\$1,963	\$0	\$46	\$476	3.66
56301	SA Fan, North HVAC Unit	10	HP ODP	0.3	2,246	0	\$141	\$0	\$56	\$578	4.09
56301	SA Fan, Central HVAC Unit	10	HP ODP	0.3	2,246	0	\$141	\$0	\$56	\$578	4.09
56301	SA Fan, South HVAC Unit	10	HP ODP	0.3	2,246	0	\$141	\$0	\$56	\$578	4.09
56301	CHW Circ. Pump 1	5	HP ODP	0.3	1,168	0	\$73	\$0	\$17	\$421	5.73
56301	CHW Circ. Pump 2	5	HP ODP	0.2	727	0	\$46	\$0	\$17	\$421	9.20
56301	Condenser Fan 1	7.5	HP ODP	0.2	661	0	\$46	\$0	\$46	\$476	10.35
56301	Condenser Fan 2	7.5	HP ODP	0.2	661	0	\$46	\$0	\$46	\$476	10.35
57305	CHW Circ. Pump 2	25	HP TEFC	0.5	2,368	0	\$149	\$0	\$2,248	\$0	\$1,6223
61701	Pool Circ. Pump	20	HP ODP	0.4	3,472	0	\$219	\$0	\$3,296	\$0	\$75
62704	SA Fan	25	HP ODP	0.6	4,974	0	\$313	\$0	\$4,721	\$0	\$87
62704	RA Fan	10	HP ODP	0.3	2,246	0	\$141	\$0	\$2,132	\$0	\$56
67601	AHU 1 SA Fan	15	HP ODP	0.5	887	0	\$95	\$0	\$1,438	\$0	\$58
67601	AHU 2 SA Fan	15	HP ODP	0.5	887	0	\$95	\$0	\$1,438	\$0	\$58
67601	AHU 3 SA Fan	15	HP ODP	0.5	887	0	\$95	\$0	\$1,438	\$0	\$58
67601	AHU 4 SA Fan	15	HP ODP	0.5	887	0	\$95	\$0	\$1,438	\$0	\$58
67601	AHU 5 SA Fan	15	HP ODP	0.5	887	0	\$95	\$0	\$1,438	\$0	\$58
67601	AHU 7 SA Fan	15	HP ODP	0.5	887	0	\$95	\$0	\$1,438	\$0	\$58
80505	SA Fan East	30	HP ODP	0.9	7,536	0	\$474	\$0	\$7,154	\$0	\$85
80505	SA Fan West	30	HP ODP	0.8	7,538	0	\$474	\$0	\$7,154	\$0	\$85

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Table 1-1. Project Group Summaries for Recommended ECOS

Building or ECO Number	Retrofit Description	Energy Savings Electric (kW)	Electric (kW/H/Year)	Gas (Million BTU/Yr)	Electric (\$/Year)	Gas (\$/Year)	Savings (\$)	O&M Savings	Utility Rebate (\$)	Investment (\$)	Payback (Years)	SIR
80505 RA Fan East	10 HP ODP	0.4	3,226	0	\$203	\$0	\$3,062	\$0	\$56	\$578	2.85	5.30
80505 RA Fan West	10 HP ODP	0.4	3,226	0	\$203	\$0	\$3,062	\$0	\$56	\$578	2.85	5.30
80505 Fan Coil Unit, Rm 213	5 HP TEFC	0.2	1,789	0	\$113	\$0	\$1,698	\$0	\$35	\$520	4.62	3.26
80505 HWF-1	7.5 HP ODP	0.3	1,459	0	\$92	\$0	\$1,385	\$0	\$46	\$476	5.19	2.91
80505 Fan Coil Unit, Rm 249	7.5 HP TEFC	0.2	1,935	0	\$122	\$0	\$1,836	\$0	\$46	\$708	5.82	2.59
80505 CHWF-1	15 HP ODP	0.4	1,959	0	\$123	\$0	\$1,859	\$0	\$58	\$766	6.21	2.43
80505 CHWF-2	15 HP ODP	0.4	1,959	0	\$123	\$0	\$1,859	\$0	\$58	\$766	6.21	2.43
80505 VAVH2 West, Roof FCU	15 HP ODP	0.2	1,676	0	\$105	\$0	\$1,591	\$0	\$58	\$766	7.26	2.08
80505 VAVH2, Roof FCU	15 HP ODP	0.2	1,676	0	\$105	\$0	\$1,591	\$0	\$58	\$766	7.26	2.08
91114 HW Circ. Pump	5 HP ODP	0.3	1,439	0	\$91	\$0	\$1,366	\$0	\$17	\$421	4.65	3.24
Subtotal, Building HVAC Control Modifications and High Efficiency Motor Retrofits		13.2	461,172	28,726	\$6,775	\$1,443	\$117,789	\$0	\$1,778	\$40,098	4.88	2.94
Lighting Fixture and Control Retrofits												
Lights A LED Exit Fixtures	108 EA	2.0	17,171	0	\$1,082	\$0	\$13,000	(\$165)	\$972	\$5,438	5.94	2.03
Lights B2 Ballasts/T8s 2xF30T12	124 EA	3.7	8,124	0	\$868	\$0	\$10,438	\$104	\$1,240	\$5,502	5.68	2.12
Lights D1 Ballasts/T8, 1xF40T12	120 EA	1.7	9,066	0	\$658	\$0	\$7,912	(\$136)	\$1,080	\$5,217	9.99	1.20
Lights D2 Ballasts/T8, 2xF40T12	1,401 EA	30.0	107,700	0	\$9,046	\$0	\$108,733	(\$48)	\$14,010	\$67,229	7.47	1.61
Lights D5 Delamp 4 to 3 T8s, Ballasts	671 EA	49.3	144,543	0	\$13,298	\$0	\$159,823	\$97	\$12,749	\$43,531	3.16	3.81
Lights E1 Ballasts 2xF48T12HO	48 EA	1.6	5,491	0	\$468	\$0	\$5,625	\$0	\$192	\$2,107	4.50	2.67
Lights F1 Ballasts/T8, 2xF96T12	20 EA	0.8	1,872	0	\$193	\$0	\$2,317	(\$32)	\$200	\$1,822	11.35	1.06
Lights F2 Ballasts/T8, 4xF96T12	1 EA	0.1	166	0	\$18	\$0	\$220	(\$3)	\$20	\$182	11.73	1.03
Lights G1 DTT 13W CF-Downlights	2 EA	0.1	139	0	\$18	\$0	\$218	\$7	\$10	\$37	1.44	8.36
Lights G2 TRI 20W Compact Fluor.	24 EA	2.4	4,547	0	\$523	\$0	\$6,284	\$278	\$35	\$62	0.08	153.60
Lights G3 TT 7W Compact Fluor.	71 EA	2.4	4,488	0	\$519	\$0	\$6,239	\$246	\$225	\$1,166	1.52	7.87
Lights G4 DTT 13W CF-Ceiling	45 EA	2.1	3,786	0	\$446	\$0	\$5,360	\$147	\$230	\$876	1.48	8.12
Lights G5 TRI 23W Compact Fluor.	28 EA	2.3	4,965	0	\$535	\$0	\$6,435	(\$88)	\$150	\$894	2.00	6.02
Lights H1 17W CF Table Lamps	249 EA	10.7	23,384	0	\$2,499	\$0	\$30,043	\$994	\$1,245	\$4,876	1.40	8.60
Lights J1 150W HPS & Ballast	33 EA	3.2	5,448	0	\$673	\$0	\$8,085	\$54	\$320	\$6,568	9.05	1.33
Lights J2 200W HPS & Ballast	54 EA	11.3	23,475	0	\$2,578	\$0	\$30,985	\$159	\$1,129	\$8,387	3.06	3.92
Lights K1 Ceiling PIR Controls	239 EA	0.0	162,912	0	\$3,877	\$0	\$94,679	\$1,676	\$1,784	\$79,611	8.33	1.44
Lights K3 Wall Switch PIR Controls	162 EA	0.0	35,138	0	\$1,699	\$0	\$20,121	\$416	\$768	\$17,829	8.43	1.42
Subtotal, Lighting Fixture and Control Retrofits		123.6	562,417	0	\$42,998	\$0	\$516,817	\$4,105	\$36,359	\$251,336	6.34	2.25
Totals for Successful ECOS (SIR's > 1.0)		203.8	1,588,955	30,117	\$90,003	\$4,526	\$1,161,876	\$3,073	\$38,137	\$525,627	6.39	2.28

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EEAP Energy Savings Opportunity Survey
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**Table 1-2. Summary of Life Cycle Cost Analyses for
 Central Heating / Cooling Plant Cogeneration Alternatives**

		Description of Cogeneration Alternative	Power kW	Investment	Annual Cost Savings			
					Energy \$/Year	Non-Energy \$/Year	SIR	Payback Years
	Alternative 1A1	\$2,923 / Kw Gas <u>Turbine-Generator</u> Cogeneration Facility serving Fort Huachuca's South Central Heating/Cooling Plant.	3,312	\$9,682,629	\$961,462	(\$29,459)	1.16	10.39
	Alternative 1A2	\$2,873 / Kw Gas <u>Turbine-Generator</u> Cogeneration Facility serving Fort Huachuca's North Central Heating/Cooling Plant.	3,312	\$9,517,018	\$935,657	(\$29,059)	1.13	10.50
	Alternative 1B	\$2,924 / kW Gas <u>Turbine-Generator</u> Cogeneration Facility serving both South & North Central Heating/Cooling Plants.	4,727	\$13,821,209	\$1,610,329	\$1,396	1.51	8.58
	Alternative 1C1	\$1,568 / kW Gas <u>Engine-Generator</u> Cogeneration Facility serving both Central Heating/Cooling Plants: Ebullient Cooled, Single-Stage Absorption Chilling.	6,600	\$10,346,129	\$1,384,319	(\$29,531)	1.74	7.64
	Alternative 1C2	\$1,654 / kW Gas <u>Engine-Generator</u> Cogeneration Facility serving both Central Heating/Cooling Plants: Two-Stage Absorption Chilling.	8,800	\$14,559,263	\$1,915,853	(\$141,775)	1.55	8.21
	Alternative 1C3	\$1,829 / kW Gas <u>Engine-Generator</u> Cogeneration Facility serving both Central Heating/Cooling Plants: Ebullient Cooled, Single & Two-Stage Absorption Chilling.	5,500	\$10,059,783	\$1,186,046	\$4,348	1.60	8.45

EEAP Energy Savings Opportunity Survey
Fort Huachuca, Arizona

**Table 1-3. Summary of Life Cycle Cost Analyses for
 Power Generation Alternatives Serving Fort Huachuca and Sierra Vista**

	Description of Cogeneration Alternative	Power kW	Investment	Annual Cost Savings
				Energy \$/Year Non-Energy \$/Year SIR Payback Years
Alternative 2	\$1,084 / kW <u>Gas Turbine Combined Cycle Cogeneration Facility serving Fort Huachuca and Sierra Vista.</u> Power generated to match electric demand.	52,248	\$56,615,344	\$17,407,722 (\$1,237,129) 1.98 6.24
Alternative 3	\$1,718 / kW <u>Gas Turbine Combined Cycle Cogeneration Facility serving Fort Huachuca only.</u> Power generation to match electric demand.	22,248	\$38,215,478	\$7,349,328 (\$481,712) 1.39 9.19
Alternative 2 Max	\$1,084 / kW <u>Gas Turbine Combined Cycle Cogeneration Facility serving Fort Huachuca and Sierra Vista.</u> Power generated at plant capacity with excess power sales through the grid.	52,248	\$56,615,344	\$22,514,378 (\$1,799,860) 1.89 5.88
Alternative 3 Max	\$1,718 / kW <u>Gas Turbine Combined Cycle Cogeneration Facility serving Fort Huachuca only.</u> Power generated at plant capacity with excess power sales through the grid.	22,248	\$38,215,478	\$9,911,580 (\$766,408) 1.54 7.83